EARLY DIAGNOSIS OF EPIDEMIC POLIOMYELITIS.*

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Our steadily increasing knowledge of poliomyelitis or epidemic acute meningoencephalopoliomyelitis (Heine-Medinsche Krankheit) brings out more clearly than ever the necessity for early recognition of the disease if it is to be combated successfully either in the individual or in the community. If a curative serum is discovered or some chemical substance found that will destroy the virus within the body it must be administered promptly before the damage to the nervous system has become irreparable; and if quarantine is to be an effective agent for common protection it must begin with the onset of the disease. It is unfortunate that our knowledge of this scourge has been so confused by the paramount importance given to its striking complication, the paralysis. The very term "infantile paralysis" is a misnomer and must be dropped from our list of names, for the disease is far from being one confined to infants and it is more than likely that paralyses including even those that are transient, occur in but a moderate percentage of those who are suffering from it. Physicians must learn to consider the paralyses only as corroborative evidence of poliomyelitis. Much as a paralysis of the palate may point to the diphtheritic organ of a preceding tonsillitis or an orchitis may permit the diagnosis of mumps to be made where the parotid glands are but little involved; so the presence of an acute limb or other paralysis can verify the presence of poliomyelitis, but it should not be necessary in order to originally make such a diagnosis. It will require a readjustment of the whole point of view for physicians to seek thoroughly in young febrile patients for hyperesthesias and muscular spasms and increased reflexes as they do for "Koplik spots" or "strawberry tongues."

Knowledge of the disease has come to the physician wrong end foremost and to get the idea of paralysis out of mind and substitute therefor the picture of an acute infectious disease with general involvement of much of the body and particularly of the nervous system is required before early diagnosis and successful treatment of poliomyelitis will be possible. In other words, the usual and ofttimes unconscious conception of the disease interferes with its prompt recognition. How few physicians consider poliomyelitis as a possibility in acute abdominal pain; and yet a study of it shows how commonly such pains occur in its course together with various intestinal, gastric and peritoneal symptoms. Transient meningismus with intestinal disturbance; rheumatic pains after exposure; traumatisms with resultant pain, weakness and inability to use the limbs; headaches and neuralgic pains with later facial paralysis; urinary retention after a long cold ride; a rash over the chest and abdomen with obstinate constipation; lacunar tonsillitis with peripheral pains and weakness, are all common enough clinical pictures and yet all may be the early and perhaps the only evidence of a poliomyelitis. It is in this complexity of symptomatology and because of the abortive cases that the great difficulty of diagnosis lies, and it will continue to do so until some proper specific test is discovered. During epidemics diagnosis is much more apt to be made, but even then many patients will recover without the cause of their ailment being clearly made out. It is probable from the fleeting character of many cases, the temporary diarrheas of those members of afflicted families who escape, perhaps "poliomyelitis carriers," the separated foci of infection, the paralytic infections of animals noted along with most epidemics that many individuals have but slight susceptibility to the disease and that trauma, fatigue, general nervous susceptibility, indigestion and concomitant infections all play a part in furthering the invasion and development of the virus in the individual patient. A review of the hundreds of case histories that I have found in the literature from the epidemics in various countries shows the peculiarly noncommittal and misleading type of symptoms presented in the so-called abortive cases and in the early days of most of those frankly paralytic later, yet there are enough striking and fairly constant symptoms to permit of an early probable diagnosis where the condition is suspected, as it is apt to be, at the time when cases are occurring in rapid succession in any district.

The variability of poliomyelitis is one of its most puzzling and evident features. For instance in the ten acute cases observed by me in California during 1911 three only were of the typical spinal type with resultant limb paralysis; of the other seven, three would be classified as "abortive," having only transient inability to use certain muscles or aversion to their use because of pain, one died with acute ascending paralysis (Landry's), one had mild meningitic symptoms resembling the meningismus complex, one had polioencephalitis with resultant hemiplegia and later death, one had simultaneously spastic and flaccid paralysis of different parts of the body with bulbar symptoms. While in practically all of these cases the nervous system was the one primarily involved yet in them all enough other systems were disturbed to make the early diagnosis difficult. This is due to the generalized involvement of the body either directly by the presence of the virus or from toxins. The work of Flexner and others showing invasion, and perhaps elimination, of the virus by the tonsil and the intestinal tract, the pathological conditions found in the liver, the splenic enlargement, the cloudy swelling of the kidneys, the general swelling of the lymphoid tissues of the intestinal tract, all indicate that Wickman's description of the disease as a "disseminated myelitis the scattered character of which is particularly prominent in the brain" only partially covers the range of body involvement. While Medin's well-known classification, as added to by Wickman, into (1) the spinal, (2) ascending (Landry's paralysis), (3) bulbar, (4) encephalitic, (5) ataxic, (6) polyneuritic, (7) meningitic, (8) abortive types, covers the

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known clinical conditions better than any other and is superior to those of Zappert and Krause, yet for a study of the abortive cases and preparalytic stages it is better to think of the relation of the disease to three sets of symptoms which overlap more or less and often become completely overshadowed when effects upon the nervous system become paramount. These are:

1. The symptoms of a general infection with predominance of gastrointestinal disorders.

2. Symptoms referable largely to the localized or generalized involvement of the nervous system as part of an apparently general infection.

3. Respiratory and throat symptoms together with the evidences of more or less extensive infection.

A patient beginning in any one of these three ways may end up with a typical paralysis or recover so promptly that he is not suspected of even having had an "abortive attack." Since apparently all cases show besides the characteristic hyperemia of the brain membranes at least some pial inflammation (Dauber and later Wickman), a careful search for nervous symptoms becomes imperative to explain the general picture, which is that of an acute infection with sudden onset accompanied usually by general malaise, headache, unexplained spontaneous pains and hyperesthesias of various parts of the body, undue weakness, fever with profuse sweats, various gastrointestinal symptoms (vomiting, constipation, distension of the abdomen, etc.) and a fast weak pulse. The discovery of changed or absent reflexes, marked hyperesthesia, neck-rigidity, stiffness of back, projectile vomiting, unexplained restlessness, stupor, coma, urinary retention, slight incoordinations of muscular movements or muscular twitchings will often clear up the situation, but unless thought of and sought for they are easily overlooked.

It is probable that the brief duration of many of the nervous symptoms as well as the frequent rapidity of recovery, is due to the fact that they owe their origin to edema as well as hyperemia, for the grayish, slightly swollen appearance of the brain and cord with some flattening of the gyri and injection of the blood vessels, especially as noted upon the cut surface, is apparently characteristic.

For a more minute discussion of the initial prodromal and other symptoms it is best to take them up briefly in the order of their relative significance. It is well to remember that at times they are so slight that they may escape the notice of a superficial parent or attendant, but a careful history almost invariably shows that close observation would have disclosed some of the usual premonitory events. The disease may come on very gradually, perhaps best expressed as a "sneaking onset," or its usual sharp initial stage may come in two (Wickman) or even three distinct periods. (Case of Neurath.) In the New York epidemic the most frequently recurring initial symptoms were, in order: restlessness, headache, apathy, rigidity of neck, stupor, convulsions; while in one of the Massachusetts epidemics they were fever, pain, tenderness, vomiting, constipation, retraction of head, diarrhea, headache, nausea, delirium, anorexia, restlessness. These differences are indicative of the various pictures presented bv poliomyelitis. The order given below represents the average importance from a diagnostic standpoint of the early symptoms as gathered from personal experience and the reports of many epidemics.

1. Hyperesthesia with Local or General Tenderness. That hyperesthesia is the most characteristic of the early signs of the poliomyelitis seems clear when numerous epidemics are compared (Wickman, Netter, Starr and Ed. Muller lay particular emphasis upon it), and it has been uniformly present in all of the early cases seen by the author of this paper. Many patients are so sensitive that crying of a low moaning sort follows the mere touching of the bedclothes or at the suggestion of combing the hair. In very young infants only acute articular rheumatism and scorbutus are apt to present the same degree of sensitiveness. Undoubtedly the urine is often retained or voided into the bed because the child fears to be touched. Standing brings on the pain and causes crying and in a suspected case pain will be elicited often by percussion along the spine. Passive movement of the limbs, especially if accompanied by pressure, usually increases the sensitiveness and is accompanied by pain. Pinching of the skin, pin-pricks, or pulling on a hair seem at times to cause agonizing pain, and there is often an increased sensitiveness to light and sounds, the teeth "feel on edge" and the patient may have the staring look full of fear and dread described as characteristic by some writers.

Over the abdomen the sudden release of the skin after pinching it up is accompanied by a marked distress. It is difficult to distinguish the pain that comes from a true hyperesthesia of the skin from the spontaneous pains in the muscles which are later affected. While the hyperesthesia may be due to a neuritis, Wickman and Menze think it comes from involvement of the pia. Undue irritability apparently due to indefinite pain or peripheral sensitiveness should invariably bring up the suggestion of a possible beginning poliomyelitis though unaccompanied by other symptoms.

2. Pain. The frequency of the occurrences of pain is indicated by the report of Dixon that it was noted in 564 out of 773 Pennsylvania cases. It may be of the meningeal type just noted as being present with hyperesthesia or it may be confined to muscles, or muscle groups, or along nerve trunks or in the chest or abdomen. This muscular pain is variously described as "aching," "cramp-like," "like the pain that follows walking too much," and it is frequently of a sharp, shooting character especially in the lower limbs. While usually spontaneous it is increased greatly by movement and pressure and it often radiates. In the lumbar region and across the shoulders it is at times severe enough to be agonizing. Very early it is apt to be occipital or cervical, but it is most characteristic when confined to the limbs where at times it seems to follow along the nerve trunks,

suggesting thereby a neuritic origin. It probably plays a large part in causing the unusual willingness shown at times by strong, healthy appearing children to remain practically motionless in bed when first affected by the disease. This unwillingness, not inability, to move is of much value in diagnosis in young children unable to report their sensations. In older individuals the pain is often noticeable in the abdomen, where its severity, associated with the usual gastrointestinal symptoms, tympany, etc., make the differential diagnosis from acute peritoneal lesions most difficult. Since the pains ordinarily disappear within a few days, a careful inquiry for evidences of previous pain must be made in all cases seen late. In this connection it is important to remember that tonsillitis may be the first indication of a poliomyelitis and that in differential diagnosis we must consder both acute rheumatism and the common peripheral and joint pains so often seen with or following the development of pus cocci in the throat. In poliomyelitis there is apt to be considerably more rigidity along the spinal column than in either of the above conditions. This sign is particularly valuable in those rare cases of poliomyelitis with swollen joints.

3. Fever. When sought for early enough, fever is probably invariably present. It may be inaugurated by a chill and be continuous or light remittent and last but a day or two, although it most often shows a rapid ascent to 102.5°-104° and persists for four days to a week. Zappert describes cases of two weeks duration and one finds in a number of case histories reference to a secondary rise after the first few days with sudden or increased paralyses. This often occurs where there is a history of severe exercise or fatigue following the early symptoms and where insufficient attention is paid to them. The fever may disappear by lysis or crisis and Müller and Meyer have called particular attention to an unusually labile rectal temperature often subnormal, found in poliomyelitis for some days after severe or even comparatively insignificant febrile states.

No relation has been shown to exist between the height of the fever and the amount of resulting paralysis—light onsets with low fever are as readily followed by paralyses as stormy ones. The more cases observed the more apparent becomes the fact that neglect, exercise and fatigue are more important than fever in relation to the paralyses, and I believe that many mild cases escape detection where children are kept quiet for a few days and that many others equally mild are made much worse by being urged or allowed to get out of bed.

4. Stiffness of the Neck and Back. All of the early cases seen by me have shown to a greater or less degree rigidity of the spinal column and stiffness of the neck. This can be elicited readily by raising the patient up to a sitting position by lifting on the back of the head. The whole spinal column is held rigid and bowed forward, producing a modified opisthotonus; and there is usually complaint of pain. In the meningitic type a high degree of neck rigidity often with retraction of the head is to be found, but even in the early days of severe cases or in abortive ones some stiffness is evident. Tension upon the head or the attempt to rise both cause pain and bring on a spasm of the neck muscles. If a child will voluntarily sit up in bed without use of the arms, caution must be used in making a diagnosis of poliomyelitis.

The wobbling of the head on the body upon movement is often characteristic of the paralytic stages of the disease, but even when it occurs pain may be present to about the same degree as in the spastic stage. It is remarkable to note that while neck paralyses occur in many cases, at least to such an extent that the head cannot be held up (39.8% in a New York epidemic), that residual neck palsies are not described in the literature.

5. Profound and Often Inexplicable General Body Weakness. This striking symptom comes early in most cases and it is usually commented upon by the parents or attendants of an afflicted child and spoken of voluntarily by older victims. The willingness to lie quietly in bed perhaps for several weeks is not uncommon even in unparalyzed cases. The disproportion between the evident general fatigue and the possible causes of it often attracts attention. It is most often noted in inability of the child to remain upon the vessel for any length of time or to sit up for meals. While ordinarily universal and often accompanied by abnormal mental states, it may be confined to individual muscle groups. When seen in children apparently but slightly ill, it has its greatest significance in diagnosis.

6. Headache. While usually headache is the first symptom, it is such a common complaint at the onset of illness that its diagnostic value is not great. The pain is of more moderate severity than that present in meningitis and there is early delirium with it. It may be frontal or diffuse, and, at times, especially when vomiting occurs, it is occipital. A general malaise is found with the pain in the head, but it is only when we have hyperesthesia of the body, neck rigidity and perhaps some apathy that it becomes definitely suggestive of a possible poliomyelitis.

7. Abnormal Mental States. Undue irritability, abnormal excitability, peevishness, and delirium may be early and prominent symptoms. Spieler has described a "Schlafsucht" lasting several days in some of the Austrian cases. While the entire sensorium is usually intact, the disturbances of consciousness at times are severe enough to cause a definite coma, the early occurrence of which does not have the grave prognostic import of its late appearance. In older children and adults the feeling of impending danger often gives a frightened expression to the face, hysterical laughing and crying may occur and a marked change in disposition is noted. The fear of death is not uncommon, perhaps due as much to the frequent dizziness and vertigo as to the general abnormal condition of the nervous system. The part that these mental states, especially vertigo, play in the accidents that often are noted in the early stages must be kept in mind.

8. Muscular Twitchings, Convulsions, Tremor. While encephalitic cases may have convulsions they are rare enough not to enter much into the diagnosis of poliomyelitis. Muscular twitching especially in the limbs is considered a common symptom by Zappert, and I have seen it in several cases and when present it is of much diagnostic importance. Tremor occurs but seldom, Wickman reporting but a single case among the many studied by him.

9. Sweating. Free perspiration or local sweating about the neck and head is so commonly reported (Starr, Krause, Ed. Müller) that it is undoubtedly a valuable symptom when acompanied by others more characteristic. At times its advent leads to a prompt relief of the pains previously the source of complaint, although in three-fourths of the cases Wickman states that it bears no relation to the fever, and is probably due to a lesion of the sweat centers or of nervous paths controlling the sweat glands.

10. Gastrointestinal Symptoms, Anorexia, Vomiting, Diarrhea, Constipation, Tympanites. As the recent work on its pathology would lead one to anticipate, poliomyelitis is almost uniformly attended by some marked interference with the normal digestive processes. Constipation has been present in most of the cases that have come under my observation, but diarrhea is the most evident symptom in some epidemics, and when it occurs the stools are reported as foul-smelling, thin and green colored. The possibility of this diarrhea, which is evidently due to the catarrhal changes in the mucous membrane and the involvement of the lymphatic system of the intestinal tract, being of an eliminatory character, has been suggested by careful observers. That the virus may be hurried out of the body in this way is perhaps worthy of note in the transient cases of acute diarrhea previously mentioned as occurring in the healthy members of families where one or two have typical poliomyelitis. Vomiting occurs early and it may be persistent and while less projectile than in meningitis, it often may occur with considerable force. Anorexia, foul breath (Lindner and Mally), coated or scarlet tongue, sordes and marked tympany as symptoms of a general paresis of the intestinal tract are commonly seen. Förster has described a toxic spasm of the abdominal muscles which adds greatly to the difficulty of diagnosis where appendicitis is suspected, and Müller emphasizes the hypotonicity of the abdominal wall with meteorism and an absence of the abdominal reflexes.

All things considered, the gastrointestinal symptoms are much more apt to lead to confusion in diagnosis than to aid, particularly since they all occur oftener in other conditions than in the one at present under discussion.

The slight enlargement of the spleen occasionally observed has to be kept in mind in this connection.

11. Vesical and Rectal Symptoms. The first clue to a proper diagnosis often comes from the unexpected failure of the patient to empty the bladder or to control the flow of urine. It is not a true paralysis of the sphincter, but is as a rule a retention, although in a few cases upon catheterization the bladder has been found empty, leading to the assumption that the anuria was due to the toxic effect of the virus upon the kidney. As Müller has stated, control may not be lost where bed-wetting occurs, but the little patient may seek to avoid the pain of being moved. Whenever the cord is markedly damaged, particularly in cases of the Landry's type, the loss of voluntary bladder and rectal control is one of the most striking occurrences just before or during the early paralytic stage. Its fleeting character is, according to L. R. Müller, due to transient and slight involvement of the sympathetic ganglia.

12. Circulatory Disturbances. A fast weak pulse (up to 140-150), often irregular and of low tension which is most marked just at the onset of the paralysis, is a very consistent symptom. Vasomotor phenomena are common, the skin is at times pale and cool, and in the Landry's type often markedly cyanotic. The hard edemas and other severe vasomotor lesions belong to the later periods of the disease. Epistaxis with or without flushing of the face and rapid pulse, while not characteristic, must be remembered as possibilities in order to avoid confusion with typhoid or other fevers.

13. Muscular Incoordination. Inability to stand or to walk, a sudden fall, or clumsiness with the hands, may be the first symptoms of poliomyelitis, and a certain amount of failure to perform complicated body movements is a fairly constant finding at some period of most cases. Previous to the paralysis the measured way in which simple movements are begun, the feeble and evidently fearful manner in which they are carried out, is of much value in diagnosis. Abortive cases are often readily recognized where with other symptoms there is a marked unwillingness to stand, especially striking where the child does not look sick.

14. Symptoms Referable to the Respiratory Tract. In some epidemics, such as the one in Hessen-Nassau described by Meyer, respiratory symptoms are the most evident early manifestations of the disease. A history of rapid respiration up to 40 or 60 without apparent cause occurs in many reports and may owe its origin to irritation of the phrenics. Marked changes in the respiration due to muscle paralyses do not occur in the preparalytic stage. Rhinitis, tonsillitis, and angina are confusing when they occur early, and with the commonly accompanying bronchitis may lead to mistaken diagnosis of influenza or even bronchopneumonia.

15. Skin Eruptions. Brown has described a skin eruption in six consecutive cases which was papulovesicular in character, superficial and of wide distribution. Petechial, macular, papular, and vesicular eruptions are fairly commonly mentioned as being present; scarlatinal blushes and even purpura are recorded in some histories. Lovett has met with poliomyelitis in association with the acute exanthemata. The rarity of the herpes labialis

mentioned by Ed. Müller is shown by the fact that among 61 cases of skin eruption in the New York epidemic only two had herpes, which is fortunately a common finding in meningitis.

16. Sensory Disturbances. Aside from the evident hyperesthesia, the older conception of the pathological changes being confined to anterior horn of the spinal cord, is shown to be incomplete by the various sensory disturbances noted in many cases. They may vary from anasthesia (Medin) to all forms of paresthesias.

17. Early Stage of Paralysis. The paralyses resulting from the effects of the poliomyelitis virus upon the central nervous system are, unless occurring in some unusual part of the body, so characteristic of the disease that when they appear diagnosis is as easy as it has been previously difficult. At present only the acute stage will be considered. At the end of the febrile period or comparatively soon thereafter, or even as the first evident primary symptom, a condition varying from reduced muscular tonus to complete flaccid paralysis with absent reflexes is discovered in some muscular group of the body, usually of the lower limbs (43% in Swedish epidemic of 1905). We know that all of the voluntary muscles of the body are liable to involvement and we may get paralysis of the outer eye muscles, disturbance of speech or swallowing, facial palsy, hemipalatal or hemidiaphragmatic paralysis as well as other forms of pure motor disturbance. Flabbiness of the muscles, reduced resistance to passive movements, pain on pressure or motion must be persistently sought for, as the paralyses are often most transient in character. The hypotonic state of the muscle is perhaps most characteristic with or without later electrical changes.

Most striking in the limbs is the frequent retention of the power to move the toes and feet, or fingers and wrists, when all control over the larger muscle groups is lost. The frequent prompt recoveries from the paralyses, seen especially in the trunk muscles, are apt to leave confusion as to diagnosis in their wake unless careful examinations are regularly made. Those cases in which slow recovery takes place or paralyses persist are ready of recognition and do not come into a discussion of early diagnosis.

Together with the study of the points above mentioned, the most valuable diagnostic help is obtained from an examination of the body reflexes, the cerebrospinal fluid, the blood and the urine. At present the feces and sputum are of but little value for such purposes, but new methods may later show the presence of the virus both in the alvine discharges and in the buccal secretions.

18. Reflexes. During the irritable stage both the Achilles and patellar reflexes are exaggerated, but they soon become very sluggish or disappear, usually one leg showing the effect first. The Achilles reflex was found exaggerated with absent knee jerk in some of Zappert's cases. If the pyramidal tract is involved, a positive Babinski with exaggerated reflexes or even ankle clonus may occur. Great care in ascertaining the presence or absence of reflexes is essential to accurate diagnosis. Because of the variations possible in muscular involvement, unusual combinations of reflexes are possible. The skin reflexes may disappear or be modified or elicited with difficulty.

Both Wickman and Linder and Mally report the absence of abdominal reflexes as a frequent finding. Since spastic conditions of the muscles occur along with the flaccid paralyses, one limb may show exaggerated reflexes with their absence in the other, while in some cases the absence of a knee reflex has been pointed out by Wickman and Ed. Muller as the only tangible symptom of the disease.

The Kernig sign is occasionally found, but when present is not as characteristic as that of Brudzinski, which consists of a prompt flexion of the legs upon the abdomen when the head is flexed forward upon the sternum.

19. Cerebrospinal Fluid. Lumbar puncture has been somewhat disappointing from the standpoint of positive diagnosis, although the examination of the cerebrospinal fluid gives much information and may permit an early distinction to be made between poliomyelitis and certain forms of meningitis. Numerous records are now available and most investigators (Flexner and Clark, Starr, Gay and Lucas, Frissell, Merzbach, Koplik, Spieler, Krause, Müller, Netter, Morse, Draper and Peabody) agree that in the early, particularly the preparalytic stages, the fluid is at a fairly high pressure, is clear or slightly turbid or opalescent with increased albumen, some globulin, containing at first from a few to as high as 90% polymorphonuclear leukocytes, but principally, then and later, an increased number of lymphocytes, and may show a central thread of clot on standing; and is bacteria free. It may be practically identical with the cerebrospinal fluid of tubercular meningitis, and where tubercle bacilli are not to be found no differential diagnosis can be made from its examination between the two conditions. Some cases of epidemic cerebrospinal meningitis are slow to present turbidity and specific organisms in the cerebrospinal fluid, but most of them, together with meningitis due to the influenzal bacillus, pus cocci, etc., are readily distinguished. In a suspected case, a prompt lumbar puncture the earlier the better, is to be uniformly recommended, although the information obtained has often only a purely negative value.

20. Blood. That the leukopenia first believed to be constant may be preceded or followed by a period of leukocytosis has been found by Frissell, Morse and Koplik. Increases in the polymorphonuclears may also occur later, perhaps as Flexner thinks from lesions in other organs than the nervous system.

In a case of the acute ascending type seen with Dr. T. M. Williams a leukocytosis of 16,400 was present and at autopsy the whole gastrointestinal tract and spleen showed evidences of some inflammation.

The relative lymphocytosis found with the leukopenia is of but little value in young children

where the lymphocytic count is apt to be high, and in adults in California, where lymphocyte counts in general are higher than those usually noted elsewhere. Draper and Peabody in a recent study of a considerable number of cases found an increased number of leukocytes up to as high as 30,000 in practically all of their cases with an increased relative number of polymorphonuclears (10 or 15%) and a corresponding decrease of lymphocytes. Hammond and Sheppard report similar findings in a few Massachusetts cases.

21. Urine. The comparatively slight damage ordinarily sustained by the renal epithelium in poliomyelitis makes urinary examination of but little positive value, except to aid in the interpretation of the symptoms such as coma, headache, etc. Bacteriological investigation, particularly when the urine is retained, is apt to show some organisms and to add to the difficulties of diagnosis. It is not to be forgotten that the presence of bacteria under such conditions in no way negatives the fact that the primary trouble is in the central nervous system, for we recognize how readily bacteria invade the genito-urinary tract under such circumstances, particularly in the presence of an abnormal gastrointestinal condition.

22. Serum Diagnosis. Especially since Netter and Levaditti and Andersson and Frost found antibodies in the blood of abortive cases, the hope has grown that in serum diagnosis the key to an early recognition of the disease will be found. The neutralization of the virus by mixing it with the blood of poliomyelitics is readily proved upon injection into monkeys, but unfortunately at present some time must elapse before its effect can be known, and from the standpoint of early diagnosis and treatment it is as yet of little value.

EARLY RECOGNITION OF THE VARIOUS TYPES OF POLIOMYELITIS.

I. Spinal. The foregoing description of the paralytic stage largely applies to the ordinary spinal form of the disease and need not be further reviewed.

II. Acute Ascending Paralysis (Landry's). Except for a shorter and stormier onset, these cases present in rapid succession many of the features of the spinal cases. They are more apt to occur in young adults and explain the higher death rate with increasing age. While there are descending forms, as a rule the paralysis begins in the legs and the destructive process rapidly climbs up the cord leaving functionless cells in its wake. When the thoracic muscles lose their power, diaphragmatic breathing occurs, and when the phrenics fail, death takes place in spite of attempts at artificial respiration. No more remarkable clinical picture presents itself than that of a healthy appearing young person with clear consciousness and intact peripheral sensation, with labored diaphragmatic breathing, but with absolute inability to move any except perhaps the most distal portions of the limbs, and physicians see but few more distressing sights than the death of such a patient.

That most cases of Landry's paralysis are due to the virus of poliomyelitis seems now well established.

III. Bulbar (Medin) or Pontine (Oppenheim). Typical hyperesthesia, sweats, and gastrointestinal conditions while occurring early in these forms are apt to disappear soon and leave the origin of the facial, hypoglossal and other paralyses obscure. Since the process is essentially more or less destructive, inflammation of the pedicle of the brain, any one or any group of the cranial nerves centering there may be involved. Even the severe disturbances have a good prognosis and the feebler ones are apt to be of such short duration that they are discovered only by painstaking and frequent observations. It is probable that some of the cases of so-called ptomaine poisoning with disturbances of swallowing and body pains are in reality unrecognized poliomyelitis of this type.

IV. Encephalitic or Cerebral. Hemiplegias of both the spastic as well as the flaccid varieties occur early or as the primary symptom in a certain proportion of cases, and there is much to support the claim that the disease should uniformly be known as polioencephalitis. For early diagnosis it is necessary to remember that extensive cortical lesions may occur, usually, but not necessarily combined with definite spinal involvement. In a case seen by me paralysis of the whole left side, excepting the muscles about the eye and forehead came on suddenly in a one year old baby after a short febrile period inaugurated by vomiting and there was some spasm of the muscles of the right side of the face. The left knee jerk was exaggerated, the right normal. Both the Babinski and Kernig signs were absent. The foot was drawn up and the fingers drawn in upon stroking respectively the sole or palm of the affected side. Sophian considers MacEwen's sign of hydrocephalus, the wooden, typmpanitic note from percussion of the frontoparietal skull region, as an important aid to the diagnosis of cerebral cases or those which he roughly classifies as "polioencephalitis."

V. Ataxic. When ataxia appears as an acute symptom in a child it may well indicate that the early damage of the virus of poliomyelitis has fallen upon the cerebellum, portions of the cord controlling the muscular sense, or the peripheral nerves particularly of the legs. While Medin and later Wickman consider it a distinct type, Zappert classifies these cases with the bulbar forms. A moderate degree of ataxia is a fairly common feature of the early stages of severe attacks especially when the lower limbs are affected.

VI. Polyneuritic. Marked sensitiveness of the nerve trunks, especially tenderness of the sciatic on stretching, occurs in some cases. When this follows angina it is apt to be mistaken for a peripheral polyneuritis of some other origin. Differentiation except perhaps by the serum test is impossible.

VII. Meningitic. Evidence is accumulating that there is a definite meningeal inflammation in all forms of epidemic poliomyelitis but in some cases the symptoms of it predominate and in some

epidemics a large proportion of such cases appear. The manifestations are often severe vomiting, headache, painful rigidity of the neck and back, jerking contractions of arms and legs, convulsions, both clonic and tonic, strabismus, and unconsciousness. The Kernig sign is apt to be present with a well marked tache cerebral; and photophobia, and irregular pupils and a deviation of the tongue have been noted by Merzbach.

Koplik has reported a series of most interesting cases showing the great difficulty of diagnosis where with meningitic manifestations, ocular and facial nuclei are involved but considers it characteristic of poliomyelitis that during the first day of fever the child is apt to seem well and to be up and that there is a gradually increasing somnolence with the addition of more meningitic symptoms. Headache, vomiting, great fatigue, somnolence after the temperature has fallen to normal, more or less hyperesthesia point to a poliomyelitic origin. The above together with a study of the cerebrospinal fluid and the backgrounds of the eye (normal in poliomyelitis) are most valuable in avoiding confusion with tubercular meningitis.

VIII. Abortive. With greater knowledge of the disease there has been a striking increase in the relative number of abortive cases reported.

No distinction can at the time be made between the preparalytic stage and the abortive forms and the factors previously mentioned must all be carefully weighed. Wickman describes the following four abortive types, together with mixed types of them.

(1) Those presenting the features of general infection.

(2) Those with meningismus-like symptoms.

(3) Those with peripheral and body pains—"influenza-like."

(4) Those with gastrointestinal manifestations. Headache, stiffness of the neck, limb pains and striking lassitude are practically uniform findings in abortive cases and any of the other symptoms mentioned may be found, the paralyses lasting for such short periods that they are often unrecognizable or misinterpreted.

DIFFERENTIAL DIAGNOSIS.

To enumerate even the names of all of the diseases with which epidemic poliomyelitis has been confused would require a long list varying from rachitis to sinus thrombosis. The acuter stages are most apt to be considered as initial symptoms of the exanthemata, or meningitis or as those of some simple gastrointestinal complaint. The most important differential points have already been enumerated in discussing the symptoms. The thought of hysteria in the clinician's mind may prevent the proper emphasis being laid upon symptoms noted. A few differential points are worth mentioning. In meningitis the pain is less constant, the convulsions more frequent, the stupor more prompt and profound, the rigidity of neck more persistent and prolonged, the paralyses more varied and irregular and the Kernig's sign more apt to be present. Then the blood and cerebrospinal fluid present the well-known characteristics. Scorbutus or rheumatism both must be ruled out in painful affections of the limbs especially in babies. The presence of abdominal pain with spasticity of the abdominal wall is apt to lead to an operation for an appendicitis. Ed. Müller describes such a case. Saltou found in the Plymouth epidemic that the acutest cases were thought to be due to sunstroke. Poisoning or suicide is not an unreasonable conclusion as to the cause of death in the acuter cases of the Landry's type.

In general it should be the aim of the clinician to attempt to eliminate poliomyelitis in all of the ordinary febrile states, above all if they present symptoms distinctly referable to the nervous system. It is well to remember that in any epidemic there is a tendency for one of the types, respiratory, gastrointestinal, etc., to predominate. One must not seek though for a single picture but with the intricate pathology in mind look for any one of a series of conditions which may dissolve readily either into a more complicated or a simpler symptom-complex or may stop abruptly at any point. It is this variability together with the firm association of the disease with paralysis, both in the mind of layman and physician, that is apt to lead to doubt as to the validity of a diagnosis in the preparalytic period and in the abortive cases. With age no longer a factor (for cases from four months to sixty-four years were reported in the Washington epidemic alone), with paralysis no longer needed for diagnosis, with the certainty that a lasting paralysis may follow the most innocent of prodromal symptoms, with the wide range of clinical possibilities resulting from the destructive processes in the nervous system we now have certainly no more complicated and no more important problem than the early diagnosis of epidemic poliomyelitis.

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THREE CLOSELY ASSOCIATED CASES OF ACUTE POLIOMYELITIS.*

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The plan of this paper is to present three closely associated cases of acute poliomyelitis and to attempt to show clearly the relationship between three distinct types and their epidemiology. I wish also to refer to the animal experiments carried on by Prof. Hans Zinsser from material derived from Case 1, and to state the anatomic changes in the cord of Case 1, as demonstrated by Prof. A. W. Meyer.

Case 1 represents the ascending or so-called Landry's type resulting rapidly in death.

Case 2, the abortive type resulting in complete recovery.

Case 3, the spinal type resulting in permanent paralysis of one leg.

With the possible exception of an obscure death in the community,* Case 1 was the first case of a small epidemic which occurred in Palo Alto, California, during the months of November and December, 1911.

Case 1. Strong, healthy high-school girl, 17 years of age, who had never been sick. She had many social engagements, was a frequenter of ice-cream parlors, and was often up late in the evenings.

First day: Came home from school at noon with distress in stomach. She had been up late the night before and had eaten candy.

Second day: Did not go to school; had pain in stomach and vomited, but was able to go out that evening.

Third day: Pain in abdomen just under ribs. Came to my office in afternoon. Stomach area tender; history and symptoms of acute indigestion. Temperature normal. Was put to bed that afternoon and given a laxative, which acted freely on the following day. No food until the next day, when she was allowed very little.

Fourth day: Remained in bed, but felt better.

Fifth day: Much better. Got up at noon and went down town. Was up until late and did not sleep well.

Sixth day: Remained in bed during the forenoon, but was up to receive a caller in the afternoon. Went to bed early and passed a restless and sleepless night.

Seventh day: I was called to see her. Patient complained of pain in lumbar region and said she felt extremely weak. Temperature normal; had no appetite and was constipated. I could discover no explanation for her condition and ascribed it to the fact that she was tired out. I learned later that she complained of some pain in legs and twitchings of leg muscles during the day. That night I gave her calomel and jalap followed by citrate magnesia in A. M.

Eighth day: Condition much the same as the day before; still constipated and a purgative enema produced but a slight movement; complained of great weakness in her arms and legs and wanted help when she got out of bed to use the commode. Severe headache and backache; had no appetite; no fever. She appeared very anxious about her condition. That night was given 5 gr. of veronal twice without result; also given more laxative.

Ninth day: After another sleepless night, she said it made her tired to breathe and that her arms felt heavy. Headache and backache more severe. Her throat felt sore and there was some distress on swallowing. There had been no result from laxative given the night before, and she had not urinated. Examination showed flaccid paralysis of both legs, except that the ankles and feet retained their power of flexion and extension. There was a marked Babinsky on both sides, otherwise reflexes absent in both legs. Arms very weak, though grip was fairly good and equal. Tactile sensation and sensation of heat and cold and of position normal. Her pupils were contracted and her lids were inclined to droop. Her neck was slightly stiff and tender, especially on deep pressure. She could rotate the head, but had pain in trying to bring the chin down. Her mind was perfectly clear; temperature elevated; pulse and respiration rapid (no record kept); abdomen distended and tender on deep pressure. It was now evident that I was dealing with a very sick patient, instead of a girl suffering the mental and physical results of indiscretions in eating and doing and who was fretting over the fact that she would be unable to attend the big intercollegiate football game which was to come off within a few days. It was also evident that she was suffering from

* Read before the Forty-Second Annual Meeting of the State Society, Del Monte, April, 1912.

* The case referred to has been, within the past week, positively diagnosticated by sections made from the medulla as poliomyelitis.